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of the Mississippi I should have been only too ready to accept the lacustrine hypothesis.

J. E. TODD.

#### A 'DRIFTLESS' RIDGE.

TO THE EDITOR OF SCIENCE: In reviewing, in the April 9th number of your journal, Professor Todd's report on the quaternary geology of Missouri, I mentioned a certain 'driftless' ridge in Pike and Calhoun counties, in Illinois, and referred its study to Mr. Frank Leverett. My attention has been called to the fact that the driftless nature of this ridge was discovered by Professor R. D. Salisbury (see Proc. A. A. A. S., Washington meeting, 1891, pp. 251-253), and that its study was largely accomplished by him.

In reference to the sections of the old and new gorges of the Mississippi river, between Montrose and Keokuk, Iowa, I wish to add to what I have said previously, that they were published through the courtesy of the Iowa Geological Survey, to which institution their preparation should be credited.

O. H. HERSHEY.

#### SCIENTIFIC LITERATURE.

*Diseases of Plants Induced by Cryptogamic Parasites.* An Introduction to the Study of Pathogenic Fungi, Slime-Fungi, Bacteria and Algae. By DR. KARL FREIHERR VON TUBEUF. English edition by WILLIAM G. SMITH. Longmans, Green & Co., London, New York and Bombay. 1897.

The German edition of this work appeared in 1895 and was the first attempt at a comprehensive treatment of the diseases of plants caused by parasites of the class Thallophyta, chiefly parasitic fungi. Such a work has been long needed, but there have been many difficulties in the way of the successful preparation of it. The fact that many of the diseases were but little known, that the organism causing them had been but little studied, and that important contributions were constantly being made to our knowledge of these forms, made it exceedingly difficult to get a book of such dimensions through the press before important changes would be necessary in order that it should properly represent the then status of the subject. While the German edition when

it appeared was welcomed because of the mass of information which was here for the first time brought together in a single book, it was notable for some important omissions, especially of work done in the United States. This was probably due in part to the fact that some of the investigations had not come to the notice of the author, and partly to a failure on his part during the press of the work to consult the American journals like the *Botanical Gazette* and the *Bulletin of the Torrey Botanical Club*. While it is evident there was no intent on the part of the author to ignore American work, the edition would have been more valuable had a little more time been given to investigations of this portion of the literature of the subject. Since, however, the work was intended primarily for the German-speaking people there is here some partial defence of the omissions.

The chief difficulty, however, that of keeping the work up to date while going through the press, was, from the very nature of the state of our knowledge of these subjects, an insurmountable one. This is forcibly illustrated in the fact that in the English edition, which appears within two years after the first edition, it was necessary to recast and rewrite the whole portion of the book which treats of the family Exoasceæ and the genus *Gymnosporangium*, so rapidly have investigations in these groups followed each other, and so greatly have the limitations of species been changed by a study of the physiological effects on the hosts on the one hand and of biological studies on the other.

In the preparation of the English edition the author, Dr. von Tubeuf, privatdocent in the University of Munich, has added much that was omitted from the first edition and has rewritten the sections already alluded to above. The English translator, William G. Smith, lecturer on plant physiology in the University of Edinburgh, has also assisted in enhancing the value of the work in some additions for which he alone is responsible. It is not often that an author is so fortunate in the selection of his translator as Dr. v. Tubeuf has been. Dr. Smith was at one time a pupil of the author in the laboratory of the University of Munich, and at the very time when the book was being prepared for the first edition, so that he was

familiar with its general plan and with the spirit of the author.

In looking over the bibliography, which includes the more important works consulted by the author and translator, it is interesting to note that the bulletins of the experiment stations in the United States have been given a place, and there are many references in the body of the work to the published investigations of several of these stations.

In defining the parasitism of the parasitic fungi, on account of the facultative nature of a large number of the species of both parasitic and saprophytic forms, the author believes that it is more correct to consider as parasites those which in their attack respond to the stimuli exerted upon them by living plant cells rather than as an adaptation to nutrition, being influenced in this respect by the researches of Pfeffer and Miyoshi. According to these investigations the stimulus seems to be a purely chemical one, and Miyoshi has shown that ordinary saprophytic fungi, as *Penicillium glaucum*, may be made to behave like a parasite by injecting a two per cent. solution of cane sugar into leaves.

The terminology applied to those forms which are not strictly obligate parasites or saprophytes is different from that employed by de Bary and others, the present author employing the terms 'hemi-parasites' and 'hemi-saprophytes.' The first chapter further deals with the mode of life of the parasitic fungi, their relation to the host and to its different tissues, and the various modifications of the mycelium into absorbent organs for the taking up of nutritive matters.

In the chapter on the reaction of the host to parasitic attack the work treats of the absorption of cell contents, the absorption of cells and tissues (notably in certain Ustilagineæ), the killing of host cells and tissues by ferments, the killing of organs or entire parts, the premature development of buds, preservation of the host plant, arrest of growth, atrophy, hypertrophy, and changes in cell contents of the host. Under the last head among other things is cited a kind of chlorosis produced by certain fungi on the host, when the green parts become bleached and lose their green color, as in the case of the attack of many of the Exoasceæ. This is

termed 'mycetogenous chlorosis.' Contrasted with this are those cases which have probably been observed by all students of parasitic fungi, in which the affected portions of the leaves or shoots remain green longer, while the unaffected parts become pale and lose their green color. A third case is termed 'mycetogenous chloranth,' that is the development of green color in the floral parts, as in the petals and stamens of *Brassica nigra* and *Sisymbrium pannonicum* attacked by *Cystopus* and *Peronospora*, and in the flowers of *Anemone ranunculoides* attacked by *Æcidium punctatum*. In some cases of hypertrophy the cell sap assumes a rose color on the sunny side, as in galls, caused by *Exobasidium* and in the bracts of the catkins of alder attacked by *Exoascus*. Carmine and yellow colors also occur, and yellow color may sometimes result from the yellow oil contents of the mycelium lying in the tissues. The accumulation of starch in parts of the host attacked by certain fungi is noted, as in the spruce needles when affected by *Lophodermium macrospermum* at a time when it is only being slowly formed in unaffected needles. Starch preservation is noted in oak wood destroyed by two fungi simultaneously. This chapter further deals with the effect of the mycelium in dissolving starch grains, wood cell walls and the effects of fungi on the anatomical structure of their hosts.

Under 'mutualism' or 'symbiosis' in the stricter sense the author first cites the much discussed case of the lichens. Here, the author claims, "as a result of the union of fungus and alga, a living organism originates, which in form necessities, and mode of life is quite new, and differs completely from either of its components." In dilating upon the evolution of this new organism the author compares it with water, which is the result of the combination of oxygen and hydrogen, or to a certain extent to the new individual, which is produced by the union of sexual cells. "These and other examples," he says, "will serve to illustrate how we have in the lichen an organism with peculiarities of structure and of life widely differing from those of either an alga or a fungus." This unification of two living beings into an individual whole the author terms 'individuation'

(individualism). While there are a number of lichenologists at the present day who accept this theory of the lichen, which has been elaborated farther by Reinke, it should be understood that there are others who are not convinced by the 'relentless' logic which separates the lichen fungi as a distinct class, but who look upon this relation of fungus and alga as parasitism in which the fungus is no more dependent on the alga than are certain other fungi upon their hosts. In the perennial parasitic *Exoascæ*, for example, the affected parts of the host in the case of such species as *Exoascus deformans*, *E. pruni*, etc., are totally unlike the normal parts of the host, and during their existence, in 'form, necessities and mode of life, differ completely from either of their components.' This deformed structure differs from the lichen only in the fact that the entire host is not a changed and 'new' being. But here there is no necessity for this, since the host is a bulky, multicellular structure, while the alga which is associated with the fungus is often an unicellular organism, or one of a few cells, or at most in a few cases a comparatively complex organism of small size, so that it could not afford a sufficient amount of nutrition for the fungus unless woven in close connection with the fungus threads.

The author recognizes that the same kind of 'individuation' which is manifested in the lichens also exists in the modified structure brought about by the parasitism of many of the fungi when he cites the negative geotropism characteristic of witches' brooms, since the new growth is no longer controlled by the same laws of growth as the normal lateral branches. Further, he points out that this structure possesses other characteristics not exhibited by normal plants when the witches' broom of the silver fir casts its needles each year. In other cases they bear no flowers or fruit. "From these facts it can be deduced that parts of plants attacked by fungi exhibit that kind of symbiosis with the fungus which we call individuation, the joint community behaving more or less as a parasite on the stem or branches of the host plant. This is clearly the case where the attacked parts exhibit increased growth, and at the same time a diminished production of chlorophyll result-

ing from degeneration of chloroplasts. Such parts of plants are quite as individualized as the lichens, with the single distinction that they remain in communication with the parent plant and draw nourishment from it."

From this it would seem reasonable to conclude that if the fungi which attack algæ are to be placed in a separate class because of this individualized condition, as some contend, these 'individualized' parts of vascular plants should be separated as another class of organisms. We do not understand, however, from his discussion that the author sanctions the separation of the lichen fungus from other fungi as a distinct class rather than on the ground of convenience. It has been a matter of convenience as well as one of taste to study and publish the lichens separately, just as it is often a matter of convenience to separate the parasitic fungi from others. But neither matters of convenience, nor taste, nor continued dependence upon some other organism and physiological amalgamation with it for limited periods, should be the ruling principle in natural taxonomy.

The word 'individuation' (individualism) is misleading, unless the author means by it that the lichen has become a being with individual traits as distinct as those beings which are recognized as individuals. If this latter interpretation is given it would seem to violate one of the fundamental criteria of an individual being, namely, that in reproduction it must pass through the one-cell stage, while the lichen thallus is never originated by less than two cells.

The author uses the term *nutricism* to denote the 'symbiotic' relation of 'mycorrhiza' to their hosts, as exemplified in the case of *Monotropa* and the filamentous fungus covering its roots, the *mycodomatia* of the alder, the legumes, orchids, etc. These general topics make up the first part of the book and cover about 100 pages.

The second part covers over 400 pages and treats first of the pathogenic fungi and lastly of the pathogenic algæ.

The fungi are taken up in the following order: Chytridiaceæ, Zygomycetes, Oomycetes, Ascomycetes, Ustilagineæ, Uredineæ, Basidiomycetes. Then follow the 'Fungi Imperfecti.' The discussion of each genus is preceded by a

description of its principal characters. A few of the important species in each genus are quite fully described and in many cases illustrated. These are followed by a further enumeration of a number of other species with their hosts and localities, the species in many cases for Britain and the United States being indicated.

The book is very fully illustrated, a very large number of the illustrations being new, either from the pencil of the author or from excellent photographs. As foot notes, there are very copious references to works even in cases where space would not permit of a discussion of their contents.

Neither the author nor the translator pretends to completeness, but modestly offer excuses for faults which under the conditions could not be well avoided. These can well be overlooked in view of the great amount of information contained in the volume which will prove to be a very useful adjunct to reference works on parasitic fungi. When a new German edition shall be called for the author promises to thoroughly revise it and expresses the wish that those who have in the past sent him copies of their investigations continue to do so in order that he may make this edition as complete as possible.

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#### RECENT BOOKS ON QUATERNIONS.

1. *Theorie der Quaternionen.* VON DR. P. MOLENBROEK. Leiden, E. J. Brill. 1891. Pp. vii+284.
2. *Anwendung der Quaternionen auf die Geometrie.* By the same author. 1893. Pp. xv+257.
3. *The Outlines of Quaternions.* By. LIEUT.-COL. H. W. L. HIME. London, Longmans & Co. 1894. Pp. 190.
4. *A Primer of Quaternions.* By A. S. HATHAWAY. New York, Macmillan & Co. 1896. Pp. x+113.
5. *Utility of Quaternions in Physics.* By A. McAULAY. Macmillan & Co. 1893. Pp. xiv+107.

The above books are all contributions to the literature of the Quaternion side of space-analysis. The first, by Dr. Molenbroek, is a care-

fully written exposition of Hamilton's theory; the author, if he does not examine the correspondence of the theory with exact science and established analysis, at least presents it so as to be internally consistent. For instance, he explains the fundamental rule  $ij = k$  as meaning that a quadrant round the axis  $j$  followed by a quadrant round the axis  $i$  is equivalent to a quadrant round the axis  $k$ . Consistently with this, he explains the rule  $i^2 = -1$  as meaning that a quadrant round the axis  $i$  followed by a quadrant round the same axis is equivalent to a reversal. The treatise, however, does not go deep enough; for the subject of quaternion logarithms and exponentials is embraced in a 9-page appendix, and what is there given is the well-known theory of coplanar exponentials. It is only when diplanar exponentials are handled that problems can be attacked which are insoluble, or at least not readily solved by the ordinary methods of analysis. Dr. Molenbroek introduces an indefinite use of  $\sqrt{-1}$  to signify a quadrant round some axis perpendicular to a given line. There are reasons for believing that in space-analysis  $\sqrt{-1}$  is scalar in its nature, and that it distinguishes the hyperbolic angle from the circular angle. Anyhow, that is one definite meaning.

The third book, by Col. Hime, presents a very dim and imperfect outline, which it would be well for the beginner to avoid. By perusing it he may get his ideas confused, not only of analysis, but of mechanics; for example, at p. 33 the terms 'version,' 'torsion,' 'rotation,' 'twist,' are all used as synonymous. This is, at least, awkward, for one of the first things which a student of quaternions must do is to distinguish between the trigonometrical composition of angles and the mechanical composition of rotations. The author explains the rule  $ij = k$  by saying that  $j$  and  $k$  each signify a unit vector, but  $i$  signifies a quadrantal versor which turns  $j$  into  $k$ . But he fails to observe that this explanation cannot apply to the complementary rule  $i^2 = -1$ , for a quadrantal versor  $i$  operating on a unit vector  $i$  would leave it  $i$ . Chapter Tenth is devoted to the 'Interpretation of Quaternion Expressions;' thus for nine chapters the reader is supposed to be dealing with symbolical expressions. Would it not be